20774
S/051/61/010/003/008/010
E032/E514

9.5320

AUTHORS: Gross, Ye. F. and Kreyngol'd, F. I.

TITLE: Infrared Absorption Spectrum of Silver Oxide

PERIODICAL: Optika i spektroskopiya, 1961, Vol.10, No.3, pp.417-418

TEXT: The present authors have investigated the infrared absorption spectrum of Ag_2O. The specimens investigated were 10 to 100 μ thick. The Ag_2O powder, which was compressed to produce these specimens, was obtained from silver nitrate-alkali reaction (M. M. Pavlyuchenko and E. Gurevich, Ref.4). The precipitated Ag_2O was washed in distilled water and dried at 80°C. In order to prevent decomposition of Ag_2O by light, both the reaction and all the subsequent operations were carried out in red light. Chemically pure commercial Ag_2O was also used. The measurements were carried out in the region 410-1500 cm^{-1}, using the ИКС-6 (IKS-6) and IKS-14 infrared spectrometers. Three absorption bands were found in the infrared spectrum of Ag_2O in the above wave number region. They are: two narrow bands at 1073 cm^{-1} and 802 cm^{-1} and a wide band with a maximum at 530 cm^{-1}. An attempt was then made to compare this spectrum with the infrared absorption spectrum of Cu_2O.

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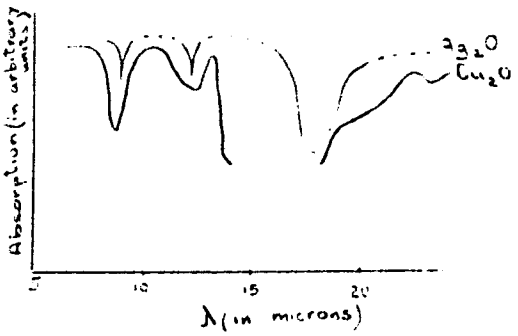
The latter has been extensively investigated by I. Pastrnyak (Ref.5). Since the Ag_2O spectrum should be displaced relative to the Cu_2O spectrum towards longer wavelengths, the 1073 and 802 bands can be directly compared with the 1124 and 848 cm^{-1} bands of Cu_2O. In fact, an estimate of the positions of the absorption bands of Ag_2O corresponding to the above two bands of Cu_2O yielded the values 1080 and 812 cm^{-1}. The discrepancy between these estimated values and the experimental values is very small and can probably be explained by differences in the lattice constants of Ag_2O and Cu_2O. Moreover, the Ag_2O bands are narrower than the Cu_2O bands. The wide Ag_2O band at 530 cm^{-1} has an absorption coefficient greater than 1000 cm^{-1} and hence can be compared with the strong absorption bands of Cu_2O with a "centre of gravity" at 630 cm^{-1}. The 530 cm^{-1} band is more displaced towards the long wavelengths than the 802 and 1073 bands. The results obtained can be explained by assuming the presence of non-polar bonds both in Ag_2O and in Cu_2O. The fraction of the homeopolar component in Ag_2O should be greater than in Cu_2O. Comparison of the absorption spectra of Ag_2O and Cu_2O shows that the absorption band at 8.9 μ

Infrared Absorption Spectrum... S/051/61/010/003/008/010
E032/E514

(Cu_2O) corresponds to the band at 9.3 μ (Ag_2O) if the mass of Cu is replaced by the mass of Ag and this directly confirms the vibrational nature of the bands. There are 1 figure and 3 Soviet references.

SUBMITTED: September 23, 1960

Figure



Card 3/3

9.4160
26.2421

2444
S/051/61/011/001/001/006
E036/E435

AUTHORS: Gross, Ye.F., Bancie-Grillot, M., Grillot, E. and Razbirin, B.S.

TITLE: Effect of machining on the absorption spectrum of cadmium sulphide crystals at low temperature

PERIODICAL: Optika i spektroskopiya, 1961, Vol.11, No.1, pp.84-86

TEXT: The absorption spectrum of cadmium sulphide crystals, obtained by different methods, were examined experimentally at 4.2°K. It was established that grinding and polishing lead to a significant change in the character of the spectrum in the region of the absorption edge. The results obtained are discussed and interpreted. Two of the authors have previously reported a group of fine, weak lines at the absorption edge of cadmium sulphide single crystals at 4.2°K, which were not due to absorption in the basic lattice (Ref.1: Gross, Ye.F. and Karryyev, N.A., DAN SSSR, 84, 471, 1952; ibid 102, 485, 1955). In addition it had also been found (Ref.4: E.Grillot, J.Phys.Rad., 17, 671, 1956; E.Grillot, M.Bancie-Grillot. Festkörper-phys. Akad. Verlag, s.226-243. Berlin, 1958; Izv. AN SSSR, ser. fiz., 22, 1356, 1958) that the method of

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Effect of machining ...

growing the very pure crystals had a marked effect on some of the optical properties. The investigation of crystals grown by the Frerichs method (Ref.5: Phys.Rev., 72, 594, 1947) and by a method developed by one of the authors (Ref.6: E.Grillot, Compt. rend., 242, 779, 1956) was therefore undertaken at 4.2°K. As the absorption is so high, it is necessary to employ very thin crystals, these being obtained by cutting and polishing, in one case to 20 microns, crystals grown by the second method above which are very thick (up to 5 mm). The latter crystals did not exhibit the line structure of the absorption edge which was very clear in crystals of the same thickness grown by the Frerichs' method. Furthermore, the absorption edge was blurred and displaced towards the longer wavelength, by about 20 Å as in curve a of Fig.1, where the absorption is plotted in arbitrary units against wavelength λ, Å; the curve b is for the Frerichs crystal of the same thickness (20 μ). That the effect was due to grinding and polishing was proved by taking a thick crystal grown by the Frerichs' method (120 μ) which exhibited the line structure at the absorption edge and grinding and polishing to 80 μ when the line structure disappeared. Also, if a piece is broken off a crystal

Effect of machining ...

grown by the newer technique so that the observation can be made without polishing the line structure is observed. Thus it is established that working the surface gives rise to an additional continuous absorption spectrum. The authors suggest that this could be due to one of two possibilities. One is that the cubic modification of CdS is formed by working the surface and the absorption edge of this form is known to be displaced towards the red (Ref.8: E.Mollwo. Reichsber. Phys, 1, 1, 1944, F.Möglich, Arbeitstag. Festkörperphys., 11, 94, 1955). The other possibility is that the working causes an amorphous layer to form on the surface or to a large number of defects and strains which could alter the crystal parameters. There are 2 figures and 9 references: 4 Soviet-bloc and 5 non-Soviet-bloc. The references to English language publications read as follows: R.Frerichs, Phys.Rev., 72, 594, 1947; P.B.Hirsch, I.N.Kellar, Nature, 162, 609, 1948.

SUBMITTED: August 1, 1960

Effect of machining ...

Fig.1. Absorption spectrum of CdS obtained by the method described by Grillot (Ref.4).

The lines λ = 4889, 4864, 4861 and 4857 Å were obscured on the original prints and are not reproduced here because of their weak intensity.

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22185

S/048/61/025/004/035/048
B117/B212

24.3500

AUTHORS: Gross, Ye. F. and Yakobson, M. A.

TITLE: Investigation of the luminescence of CdS single crystals at low temperatures

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, v. 25, no. 4, 1961, 531-532

TEXT: The present paper was read at the 9th Conference on Luminescence (crystal phosphors). The authors have continued their investigation of the luminescence of CdS single crystals. The short wave line group which corresponds to the short wave absorption of the CdS single crystal at $T = 4.2^{\circ}K$ has been studied. The luminescence spectrograph obtained showed that the short wave bands (λ = 4788, 4828 and 4852 A) are weak due to reabsorption. If these short wave bands are considered to be principal bands then it is possible to contrast them with satellites at a distance of 300 cm^{-1}. But these are not contained in the oscillation series of the long wave luminescence. The effect of treating CdS single crystals with sulfur and cadmium vapors on their spectra has also been investigated. The

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22186
S/048/61/025/004/035/048
B117/B212

Investigation of the...

purpose of these tests has been to clear the nature of defects which are responsible for the origin of the long wave line group of the light-blue luminescence. It has been found that after the treatment with sulfur vapors long wave luminescence and absorption will disappear completely. After using cadmium vapor these spectra will essentially stay the same. The test results allowed the following conclusions: The short wave luminescence lines and the corresponding absorption bands can be considered an annihilation of the exciton in the crystal lattice during light emission. The origin of long-wave light-blue luminescence can be referred to the presence of defects in the crystal lattice. And it may be assumed that the junctions responsible for the origin of long wave emission will take place in the lattice near various defects. Furthermore, it is assumed that the long-wave line groups in the absorption spectrum and in the spectrum of light-blue luminescence of the CdS crystal are connected with the excitation and emission of ortho-excitons. They are formed by light excitations under the influence of the disturbing effect of defects. Therefore, the short-wave line group should be compared with para-excitons. S. A. Moskalenko has stated the following in a discussion about this paper: In order to explain the CdS spectra the authors have used the

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S/048/61/025/004/035/048
B117/B212

Investigation of the...

hypothesis of ortho and para excitons. According to their opinion ortho excitons are allowed because of the interaction with impurities. A separation of ortho and para excitons depends on the exchange interaction. If this is very small then it points to a large-enough radius of the excitons; the spin-orbit coupling at the impurity potential is small and the ortho excitons are not intensive. There are 7 references: 5 Soviet-bloc and 2 non-Soviet-bloc.

ASSOCIATION: Fiziko-tekhnicheskiy institut Akademii nauk SSSR (Institute of Physics and Technology, Academy of Sciences USSR)

X

Card 3/3

22187

S/048/61/025/004/036/048
B117/B212

24,7400
24,3500

AUTHORS: Gross, Ye. F. and Suslina, L. G.

TITLE: Investigation of the absorption and the luminescence of ZnS and ZnSe single crystals

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya, v. 25, no. 4, 1961, 532-533

TEXT: The present paper has been read at the 9th Conference on Luminescence (crystal phosphors). The authors have investigated the absorption, reflection, and luminescence spectra of ZnS and ZnSe single crystals near the long-wave edge of the principal absorption at temperatures of liquid helium. ZnS and ZnSe single crystals have been obtained in form of plates by sublimation of powder in a neutral gas medium. They belong to the hexagonal modification with a sixfold axis in the plate plane. The maximum dimensions of the crystals are: ZnS - 25 × 5 × 0.1 mm and ZnSe - 7 × 1.5 × 0.1 mm. The spectra have been studied at T = 4.2 °K in polarized light from photographs of samples of various thicknesses. It has been found that the long-wave edge of the self-absorption of ZnS

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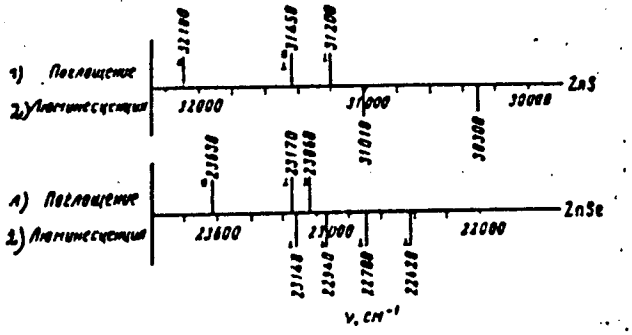
Investigation of the...

and ZnSe single crystals has a complicated structure and shows several small, intensive, polarized absorption lines at T = 4.2°K. A line luminescence has been observed at the absorption edge of both crystals. Between the short-wave emission lines and the long-wave absorption line a resonance has been established. The relative distribution, the polarization, and the width of the lines are very similar in absorption spectra of isomorphous ZnS and ZnSe crystals. Considering the position of the absorption edge, the stability and the high absorption coefficient ($\sim 10^4 \div 10^5$ cm^{-1}) it can be assumed that the established absorption caused by the structure is due to the absorption of the basic substance in the lattice, i.e., the formation of excitons. The luminescence spectrum of ZnS has been obtained from fine-crystalline powder at 77.3°K. At T = 4.2°K, an intensive line structure has been found in the luminescence spectra of ZnSe single crystals. An equidistant band group which can be found in a number of oxyde and sulfide crystals is found here. The gap between equidistant bands ($\Delta\nu \sim 260$ cm^{-1}) corresponds in magnitude to the lattice vibration energy of ZnS. Taking into account that there is a resonance between the short-wave luminescence lines of

Investigation of the...

ZnS and ZnSe and their long-wave absorption lines, it has to be assumed that the line emission of crystals has to be referred to the exciton annihilation in the lattice at light emission. The figure shows schematically the position of the absorption and luminescence band centers and their polarization in ZnS and ZnSe crystal spectra. [Abstracter's note: Essentially complete translation]. There is 1 figure.

Legend to the figure:
1) Absorption;
2) luminescence.



Card 3/3

GROSS, Ye.F.; KAPLYANSKIY, A.A.

Quadrupole absorption and the optical lifetime of the ground state of excitons in a Cu_2O crystal. Dokl. AN SSSR 139 no.1: 75-78 Jl '61. (MIRA 14:7)

1. Fiziko-tekhnicheskiy institut AN SSSR. 2. Chlen-korrespondent AN SSSR (for Gross).
(Excitons--Spectra) (Copper oxide crystals)

2811
S/020/61/140/006/010/030
B104/B102

9.4160
26.2421

AUTHORS: Gross, Ye. F., Corresponding Member AS USSR, Razbirin, B. S., and Safarov, V. I.

TITLE: The Stark effect on the exciton levels of a cadmium-sulfide crystal

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 140, no. 6, 1961, 1285 - 1288

TEXT: The authors studied the Stark effect on the exciton lines of the absorption spectrum of thin CdS crystals (from some tenths of microns up to 10μ) at 4.2°K. When examining the first series of lines, $\Gamma_7^+ - \Gamma_9$ the authors used an electric field whose direction coincided with the optical axis C of the crystal. If the polarization of light is parallel to the optical axis (E∥C), the lines corresponding to the excited exciton states will be most sensitive to the electric field. Up to electric field strengths of 10 to 15 kv/cm no shift of the line n = 1 of this series was observed. From 100 v/cm onward the lines n = 2, n = 3 and n = 4 showed a broadening. The short-wave component was shifted toward the violet,

29811
S/020/61/140/006/010/030
B104/B102

The Stark effect on the exciton levels

and the satellite line λ = 4814.8 Å of the line λ = 4815.2 Å (n = 2) was shifted toward the red. When the polarization of light was perpendicular to the optical axis (E⊥C), the line n = 1 of the first series showed no shift. The satellite of the line n = 2 and its short-wave component are polarized in an electric field with E⊥C. The long-wave component of the line n = 2 is polarized in an electric field with E∥C. The Stark effect of the lines n = 3 and n = 4 with E⊥C could not be examined. The Stark effect in electric fields perpendicular to the optical axis of the crystals showed the same character. The first line (n = 1, λ = 4826.5 Å) of the second series of lines ($\Gamma_7 - \Gamma_7$) showed no Stark effect up to field strengths of 10 - 15 kv/cm. The second line (n = 2, λ = 4785 Å), was split up into two lines, independently of the orientation of the electric field to the optical axis of the crystal. With increasing field strength the short-wave component shifted toward the violet, while the long-wave component shifted in opposite direction. The results obtained here indicate that the exciton dimensions in a CdS crystal are large and increase with increasing line frequency (quantum number n). The intensity of the satellites of the lines n = 2 and n = 3 increases with increasing field

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strength. The results obtained agree with those of J. L. Birman (Ref. 9), D. G. Thomas et al. (Ref. 6), and A. Lempicki (Ref. 10). There are 4 figures and 10 references: 6 Soviet-bloc and 4 non-Soviet. The three most recent references to English-language publications read as follows: Ref. 6: D. G. Thomas, J. J. Hopfield, Phys. Rev. 116, 573 (1959); Ref. 9: J. L. Birman, Phys. Rev. Letters, 2, no. 4, 157 (1959); Ref. 10: A. Lempicki, Proc. Phys. Soc., 74, no. 475, 138 (1959).

SUBMITTED: July 26, 1961

Card 3/3

24.3500 (1137, 1138, 1144)
76.2421

33359
S/181/62/004/001/032/052
B104/B102

AUTHORS: Gross, Ye. F., and Razbirin, B. S.

TITLE: Fine structure of the exciton absorption lines of cadmium sulfide single crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 1, 1962. 207 - 212

TEXT: The fine structure of exciton absorption lines (λ = 4853.0 Å; λ = 4813.2 Å; λ = 4805.8 Å; λ = 4803.5 Å) was studied by light polarized parallel and perpendicular to the optical axis of a CdS crystal. The fine structure of the first two lines is fully described. The behavior of these lines cannot be explained with the ordinary crystal optics. The authors attempt to explain it by using assumptions by S. I. Pekar (ZhETF, 33, 1022, 1957; 34, 1176, 1958, 36, 451, 1959; 38, 1786, 1960; 35, 522, 1958; FTT, 2, 261, 1960). Hence in the exciton absorption range longitudinal and transverse excitons may propagate in a crystal. If the smallness of the light wave vector is not neglected their frequencies are different. The components λ_1 = 4853.0 Å and λ_2 = 4854.8 Å of the first line of the exciton series $\Gamma_9 - \Gamma_7$ and the components λ_3 = 4813.2 Å and λ_4 = 4814.0 Å of the

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33359
S/181/62/004/001/032/052
B104/B102

Fine structure of the exciton...

second line of this series are considered to be frequencies of longitudinal and transverse excitons in the CdS crystal. Owing to experimental difficulties the dependence of the exciton absorption lines on the angle between light beam and optical axis could not be proved as is required by Pekar's theory. There are 3 figures and 14 references: 10 Soviet and 4 non-Soviet. The four references to English-language publications read as follows: W. R. Heller, A. Marcus, Phys. Rev., 84, 809, 1951; J. J. Hopfield, D. G. Thomas, J. Phys Chem. Sol., 12, 276, 1959; J. L. Birman, Phys Rev. Lett., 2, 157, 1959; D. G. Thomas, J. J. Hopfield, Phys. Rev., 116, 573, 1959.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: July 27, 1961

Card 2/2

X

33360
S/181/62/004/001/033/052
B104/B102

24,3500 (1137, 1138, 1144)
26.2421

AUTHORS: Gross, Ye. F., Raztirin, B. S., and Shekhmamet'yev, R. I.

TITLE: Spectral distribution of the excitation of edge luminescence of CdS crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 1, 1962, 215 - 216

TEXT: The authors studied the excitation spectrum of green luminescence of CdS crystals at 77°K. An incandescent lamp whose light fell on the crystal surface through a monochromator with an angle of 50 - 80° served as light source. According to the shape of their luminescent excitation curves the CdS crystals can be divided into two groups. In the first group the maxima of the excitation curves of green luminescence coincide with the absorption lines of the crystals. In the second group the minima of these curves coincide with the absorption lines. If a crystal of the first group is heated to 250°C and then rapidly cooled in liquid nitrogen it then belongs to group two. By heating crystals of the second group they could not be transformed into crystals of the first group. Due to these heat treatments only the minima became more shallow and the short-wave part of the luminescence excitation curve became more intense. This property of the CdS

Card 1/2

Spectral distribution of the excitation...

crystals is explained by the fact that photoconductivity and luminescence are produced by the excitons. The maxima and minima of the excitation curves and their behavior on heat treatment is related to the annihilation (recombination) of excitons. B. V. Novikov (FTT, 1, 357, 1959; ZhTF, XXVIII, 782, 1958) is mentioned. There are 2 figures and 8 references: 6 Soviet and 2 non-Soviet. The two references to English-language publications read as follows: C. C. Klick. Phys. Rev., 86, 659, 1952; 89, 274, 1953; D. Patton. J. Phys. a. Chem. Sol., 6, 101, 1958.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet (Leningrad State University)

SUBMITTED: August 3, 1961

Card 2/2

33365

S/181/62/004/001/041/052
B111/B104

24,3500 (1137,1138,1144)

AUTHORS: Gross, Ye. F., and Chan Kuang-yiu

TITLE: New series of exciton lines in the light- and dark-blue spectral ranges of cuprous oxide crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no 1, 1962, 261 - 264

TEXT: Possible exciton transitions from the valence band to higher sub-zones of the conduction band were studied. Transitions to the lowest sub-zone have already been found by A. G. Zhilich (Ref. 2: Vest. LGU, no. 22, 5, 1959; no. 10, 5, 1960) and S. A. Moskalenko (Ref. 2: FTT, 2, 1755, 1960; ZhOS, 2, 369, 1960). I. Pastrnyak and R. A. Titov (Ref. 4: FTT, 3, 861, 1961) were the first to investigate the new exciton lines. A more precise investigation has now revealed new weak reflection lines at helium and nitrogen temperatures:

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33305
S/181/62/004/001/041/052
B111/B104

New series of exciton lines ...

Group	Quantum number n	Wave number ν_n (cm^{-1})	Half-width Å 77.3°K	Half-width Å 4.2°K
light blue	2	20847	15	12
	3	21137	-	4
	4	21240 (?)		-
dark blue	2	21901	35	25
	3	22192		8

Series laws: (a) for the light-blue range:

$$\nu_n = 21369 - \frac{2088}{n^2} \text{ (cm}^{-1}\text{)}, \quad n = 2, 3, 4, \ldots$$

(b) for the dark-blue range:

$$\nu_n = 22425 - \frac{2095}{n} \text{ (cm}^{-1}\text{)}, \quad n = 2, 3, 4, \ldots$$

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S/[illegible]/62/004/001/04[illegible]/052
B111/B104

New series of exciton lines ...

From the occurrence of lines in the light and dark-blue ranges, it is concluded that the corresponding absorption lines are very intense. In the light-blue range there are three broad absorption lines which do not coincide with the corresponding reflection lines but are shifted by 8 - 20 Å. Only the absorption minimum coincides with the peak of the corresponding reflection line within the error of measurement. It is assumed that deformation strains are responsible for these shifts which were particularly distinct in fine-crystalline Cu_2O layers examined by L. Ye. Solov'yev. The extremely close dependence of the reflection lines on the surface defects of the crystal indicates that these lines are dependent on the entire lattice structure. For this reason these intense sharp lines are attributed to exciton transitions. The measured values were compared with the models of Zhilich and Moskalenko, and the formation of exciton lines was interpreted. There are 3 figures, 1 table and 4 references: 3 Soviet and 1 non-Soviet. The reference to the English language publication reads as follows: R. J. Elliot Phys. Rev., 108, 1384 1957

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR
Leningrad (Physicotechnical Institute imeni A. F. Ioffe

Card 3/4

31365
S/181/62/004/001/041/052
B111/B104

New series of exciton lines ...

AS USSR Leningrad)

SUBMITTED: September 2, 1961

X

Card 4/4

9.4177 (also 1051, 1035)
26.4421

33367
S/181/62/004/001/047/052
B112/B138

AUTHORS: Gross, Ye. F., and Kreyngol'd, F. I.

TITLE: Optical and photoelectric properties of mercury sulfide in the main absorption edge range

PERIODICAL: Fizika tverdogo tela, v. 4, no. 1, 1962, 291 - 293

TEXT: Studying the diffuse reflection spectrum, the authors found the absorption edge of HgS to be 6100 Å at room temperature and 5590 Å at 77°K. The forbidden band width was $9 \cdot 10^{-4}$ ev/grad. The absorption band lies between 5510 and 5560 Å at 77°K. Fig. 1 shows the spectral distribution of the photoconductivity of two groups of HgS crystals (T = 77°K). The absorption line of the first group (a) corresponds to the maximum and that of the second group (b), to the minimum of the photo current. Fig. 2 shows the spectral distribution of the photoconductivity of a HgS crystal in the region around the electrodes (T = 77°K). There is no

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33309
S/181/62/004/001/047/052
Optical and photoelectric... B112/B138

infrared quenching for HgS crystals of the second group at room temperature. There are 2 figures and 4 references: 2 Soviet and 2 non Soviet. The reference to the English-language publication reads as follows: D. R. Hamilton. Brit. J. Appl. Phys. 9, 103, 1958.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet (Leningrad State University)

SUBMITTED: September 11 1961

Card 2/2

M232
S/181/62/004/002/011/051
B102/B138

24.3500 (1137, 1138, 1144)

AUTHORS: Gross, Ye. F., Suslina, L. G., and Kon'kov, [illegible]

TITLE: Exciton spectrum of hexagonal CdSe single crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 2, [illegible], 429-[illegible]

TEXT: Exciton absorption and reflection spectra were obtained at 4.2°K on CdSe plates with a maximum area of 10 mm^2 and depths ranging from a few to some tens of microns thick. They were obtained by evaporating CdSe powder in an argon atmosphere. The measurements were carried out in polarized light with an ISP-28 (ISP-28) spectrograph with a linear dispersion of 45 Å/mm in the 4550 Å range, and an MDR-[illegible] (ISP-[illegible]) with 2.5 Å/mm dispersion in the same range. The absorption coefficient was 10^3-10^4 cm^{-1}. For E⊥c the absorption edge was 4550 Å, for E∥c at 4295 Å. The absorption line (A) with maximum at 4555 Å and ~10 Å in width is in the extraordinary ray, and is intensified as the angle between E and c increases. It was studied in detail. With an Ec angle of up to [illegible]° a side line (B) appears with 4511 Å, which [illegible]

Card 1/[illegible]

X

34232
S/181/62/0.4/.../...
B102/B138

Exciton spectrum of hexagonal ZnSe ...

tion. The same effect of extraordinary-ray line intensification when rotating the crystal was observed with CdS, CdSe, ZnS and HgI$_2$. The reflection spectrum for E // c has a peak at 42.. Å, a dip at 42.. Å. Chang Kuang-yin has observed this line (C) at 42.. Å. This value is taken to be correct. The ZnSe exciton spectrum is confronted with theoretical results and with results for ZnS at 4.2°K:

Position and polarization of exciton lines

ZnS	Polarization	ZnSe	Polarization
3.0. Å	E ⊥ c	4555 Å	E ⊥ c
3.60	-	4511	E ⊥ c
3.15	E ∥ c	3257	E ∥ c

The energies of valence band splitting, E_{AB} and $E_{A..}$, were also determined and compared with those of ZnS (Table 2). ... A. Zholkevich (...) Vol. ... ped. Inst. 22, 105, 19..), B. S. Razbirin and ... (FTT, 2, 2954, 1960) are mentioned. There are 3 figures, ... tables, and ...

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S/181/62/004/002/015/051
Exciton spectrum of hexagonal ZnSe ... B102/B138

17 references: 9 Soviet and 8 non-Soviet. The four most recent references to English-language publications read as follows: D. G. Thomas, J. J. Hopfield. Phys. Rev. 116, 573, 1959; J. L. Birman. Phys. Rev. Lett., 2, 157, 1959; J. J. Hopfield. J. Phys. Chem. Sol., 15, 97, 1960; D. G. Thomas. J. Phys. Chem. Sol. 15, 86, 1960.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: August 16, 1961

Card 3/4

24,6200
26,2420

36881
S/181/62/004/004/025/042
B102/B104

AUTHORS: Gross, Yu. F., Zakharchenya, B. P., and Sibilev, A. I.

TITLE: Zeeman effect of indirect excitons in Cu_2O crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 4, 1962, 1003-1008

TEXT: The Cu_2O spectrum shows, apart from the hydrogen-like series, a continuous stepwise absorption; the first step begins at 6164 Å, the second at 6085 Å ($T = 77.3^{\circ}K$). This stepwise absorption can be explained among others by the optical spectrum of polaron formation or indirect exciton transitions due to exciton interaction with monochromatic phonons ($E_{ph} = 105$ cm^{-1}). The latter model was proposed by R. J. Elliott (Proc. Internat. Conf. on Semicond. Phys. Prague, 406, 1960; Phys. Rev. 124, 340, 1961). It is in good agreement with the observed dependence of the absorption coefficient on the frequency of the light absorbed: $k \sim (h\nu - E_0)^{1/2}$, E_0 is the energy at the beginning of the step; it was checked by epxeriments of the effect of uniaxial deformation on the short-

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wave edge of the first absorption step (FTT, 4, 2965, 1962). A further check was made now when studying the Zeeman splitting of the absorption edge at 5760 Å. The pulsed magnetic field (half-period 3 msec) was produced by a liquid-nitrogen cooled solenoid. The Cu_2O single crystals were cooled to 77.3°K and exposed to that field in parallel to the directions [100], [110], and [111]. The experimental conditions are given by

/ $\mathbf{H} \parallel [100]_z$;	$\mathbf{q} \parallel [100]_y$;	$\mathbf{e}(p) \parallel [100]_z$;	$\mathbf{e}(s) \parallel [100]_x$;
// $\mathbf{H} \parallel [111]_{yz}$;	$\mathbf{q} \parallel [1\bar{1}0]_{xy}$;	$\mathbf{e}(p) \parallel [111]_{yz}$;	$\mathbf{e}(s) \parallel [11\bar{2}]_{\bar{x}y}$;
/// $\mathbf{H} \parallel [110]_{xy}$;	$\mathbf{q} \parallel [1\bar{1}0]_{\bar{x}y}$;	$\mathbf{e}(p) \parallel [110]_{xy}$;	$\mathbf{e}(s) \parallel [100]_z$.

The vectors $\vec{q}$ and $\vec{e}$ denote the directions of light propagation and its polarization. In all cases, the measurements were made for $\vec{E} \perp \vec{H}$ and $\vec{E} \perp \vec{H}$. With all orientations, the splitting of the quadrupole exciton line with n=1 was observed, the total amount of the splitting was 4 Å. The center of gravity of the triplet was red-shifted and the triplet was asymmetric. Besides the quadrupole line also the edge at 6085 Å was split; number and position of components were dependent on the geometry of the experiment

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S/181/62/004/00../025/042
B102/B104

Zeeman effect of indirect...

(Fig.). The results are analyzed in detail and it is found that, in agreement with Elliott's theory, the steps in the continuous absorption correspond to combined exciton-phonon transitions. The phonon involved has the symmetry Γ_{12}^{-}. The continuous exciton absorption in the range of indirect transitions is indicative of exciton energy bands connected with an exciton migration in the crystal. A. G. Zhilich is thanked for discussions. There is 1 figure.

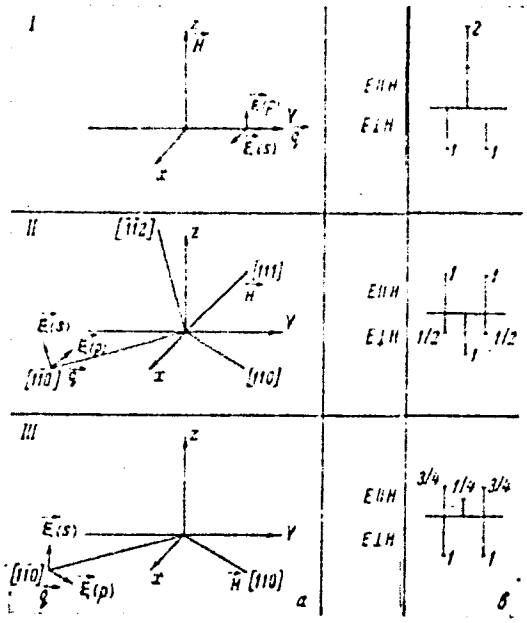
ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: December 13, 1961

Card 3/4

Zeeman effect of indirect...

S/181/62/004/004/025/042
B102/B104



Card 3/4

1.2180
1.2200
2.2220

S/181/62/004/004/026/042
B102/B104

AUTHORS: Gross, Ye. F., Kaplyanskiy, A. A., and Akekyan, V. T.

TITLE: Effect of oriented deformation on the spectra of direct and indirect excitation of the exciton ground state in Cu_2O crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 4, 1962, 1009-1015

TEXT: Gross and Kaplyanskiy had already shown (FTT, 2, 1676, 2968, 1960) that uniaxial compression of Cu_2O crystals leads to splitting of the first component (n=1, 6125 Å) of the yellow exciton series and of the two edges (6165 and 6085 Å) of continuous absorption. For $P \perp C_4$ and $P \parallel C_3$ a doublet arises, with $P \parallel C_2$ - a triplet; P is the compression direction. 4

These studies were continued. While the previous measurements were made in "transverse" geometry ($L \perp P$), now they were made in "longitudinal" one ($L \parallel P$); L is the direction of light propagation. The measurements were made again at 77°K and with ДФС-51 (ISP-51) spectrograph and an УФ-85

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Effect of oriented deformation...

(UF-65) camera. The compression load was 10-20 kg/mm^2. Results: With $P \perp C_4$, line and edges were only red-shifted and not polarized. With $P \parallel C_3$, the line was shifted toward shorter waves, the edges were split into doublets and red-shifted; no polarization. With $P \parallel C_2$, the line was slightly red-shifted, the edge was split into a triplet and the spectrum was polarized. With $E \parallel C_4$ ($C_4 \perp P$), only the first edge was seen which was red-shifted; with $E \perp C_4$, both edges were seen, the first was slightly red-shifted, the second was shifted considerably toward shorter waves. The results of both studies ($L \perp P$ and $L \parallel P$) were analyzed on the basis of Elliott's theory (Proc. Internat. Confer. Semicond., Prague, 408, 1960; Phys. Rev. 124, 340, 1961) of the connection between these edges and indirect exciton transitions in the band n=1 (combined exciton-phonon transitions). The good agreement between this theory and the experimental results speaks in favor of the theory. The symmetry type of the phonon involved is assumed to be Γ_{12}^-. It can also be assumed that exciton migration takes place in Cu_2O. There are 1 figure and 1 table.

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ASSOCIATION: Fiziko-tekhnicheskiy institut im.A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: December 13, 1961

Card 3/3

24.2600
24.5712

S/181/62/004/005/011/055
B125/B104

AUTHORS: Gross, Ye. F., Lider, K. F., and Novikov, B. V.

TITLE: Spectral examination of the photoconductivity curves of CdS crystals at 77 and 4°K in the region of the absorption edge

PERIODICAL: Fizika tverdogo tela, v. 4, no. 5, 1962, 1135 - 1139

TEXT: Plates of CdS single crystals affixed to quartz backings were used to study the effect of temperature on the shape of the spectral curves of photocurrent and the coincidence between the absorption maxima and the values of photocurrent. Cooling from 77 to 4°K produces the following effects: Like the absorption spectrum, the curves are also shifted toward shorter wavelengths. All curves obtained at 4 and 77°K may be divided into two groups according to the coincidence between their absorption maxima and their extreme values of photocurrent. In the first group, the absorption lines correspond to photocurrent maxima, and in the second, they correspond to minima. On the short-wave section of the curves, the photosensitivity of crystals belonging to the second group at 77°K was higher

Card 1/2

Spectral examination of ...

than on the long-wave section. The coincidence between the photocurrent curves and the absorption maxima changes substantially. Crystals belonging to the second group at 77.3°K belong to the first at 4.2°K. A similar observation can be made with some CdS crystals in the range 300 - 77°K. The photosensitivity of so-called "mixed crystals" heated to room temperature increases abnormally in the long-wave pseudomaximum, and increases also in the short-wave section when they are cooled from room temperature to 77°K. It is noted that crystals with many surface and bulk defects yield spectral curves of the first type for any temperature, while crystals with only few defects afford curves of the first type. Hence, defects are nonuniformly distributed throughout the volume of mixed crystals. There are 5 figures. The most important English-language reference is: E. F. Gross a. B. V. Novikov. Bull. Amer. Phys. Soc., Ser. II, 6, 5, 478, 1961.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet (Leningrad State University)

SUBMITTED: December 12, 1961

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S/181/62/004/006/043/051
B108/B138

AUTHORS: Gross, Ye. F., Kaplyanskiy, A. A., Agekyan, V. T., and Bulyanitsa, D. S.

TITLE: Polarization of the yellow exciton series in the Cu_2O spectrum on deformation of the crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 6, 1962, 1660-1666

TEXT: The effect of uniaxial compression of Cu_2O crystals along the <100>, <110>, and <111> axes on the yellow exciton series was studied. A long-wave displacement of the series was observed. Anisotropic absorption was found but there was no splitting of the yellow series. Polarization of the absorption of the yellow series on deformation is explained by "direct forbidden" transitions (R. J. Elliott. Phys. Rev., 108, 1384, 1957) into exciton states and by band-to-band transitions, which are due to nearby excited bands. There are 1 figure and 1 table.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

Card 1/2

Polarization of the yellow ...

S/181/62/004/006/043/051
B108/B138

SUBMITTED: December 13, 1961 (initially)
March 5, 1962 (after revision)

Card 2/2

S/181/62/004/008/019/041
B102/B104

AUTHORS: Gross, Ye. F., Kaplyanskiy, A. A., and Agekyan, V. T.

TITLE: Deformation-induced splitting of the blue and the dark blue exciton series in the Cu_2O crystal spectrum

PERIODICAL: Fizika tverdogo tela, v. 4, no. 8, 1962, 2169 - 2178

TEXT: Single-crystal Cu_2O plates cut in parallel to (100), (110) or (111) planes were compressed at 77°K in the directions <100>, <110> or <111> respectively. It was then examined how the compression influenced the reflection spectrum (normal reflection, observation perpendicular to pressure P direction). P||[001]: Broad and almost symmetrical splitting, doublet components polarized. P||[111]: no splitting, no polarization; P||[110]: medium and almost symmetrical splitting, doublet components polarized. The position of the doublet line (ν) related to that of the original line (ν_0) depends not only on the direction but also on the magnitude of the pressure: $\Delta = \nu - \nu_0$ depends linearly on p. A calculation of the deformation-induced line splitting shows that at $\vec{k} = 0$ the

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highest conduction band is of the type Γ_{12}^-. As the splitting is similar in both series the exciton band splitting must be due to splitting of the upper conduction bands which are the same in both. An investigation of the optical transitions in the bands Γ_8^- (Γ_{12}^-) shows that in Γ_8^- (Γ_{12}^-) the relative intensity of polarized absorption is equal for transitions from Γ_7^+ (blue) and from Γ_8^+ (dark blue). Qualitatively the theoretical results agree well with the experiments. If σ is given in kg/mm^2,

$$\Delta\ \text{см}^{-1} = -2.7(\sigma_{xx}+\sigma_{yy}+\sigma_{zz}) \pm \quad (12).$$
$$\pm 25\sqrt{\frac{(\sigma_{xx}-\sigma_{yy})^2+(\sigma_{yy}-\sigma_{zz})^2+(\sigma_{zz}-\sigma_{xx})^2}{2}}$$

Thus the amount, multiplicity and polarization of the exciton series splitting correspond to the calculated characteristics for the splitting of the transition Γ_7^+, Γ_8^+ (Γ_{25}^+)$\rightarrow\Gamma_8^-$ (Γ_{12}^-). There are 4 figures and 1 table.

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Deformation-induced splitting of the... S/181/62/004/008/019/041
B102/B104

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR
Leningrad (Physicotechnical Institute imeni A. F. Ioffe
AS USSR, Leningrad)

SUBMITTED: March 22, 1962

Card 3/3

44184
S/181/62/004/012/048/052
B125/B102

9.4160

AUTHORS: Gross, Ye. F., Razbirin, B. S., and Sokolov, V. I.

TITLE: Bound excitons and band structure in a CdS-crystal

PERIODICAL: Fizika tverdogo tela, v. 4, no. 12, 1962, 3673-3675

TEXT: The hypothesis that bound excitons are produced from free excitons of the type $(\Gamma_9-\Gamma_7)$ and from free excitons of the type $(\Gamma_7-\Gamma_7)_1$ at the shift of the level of the free excitons near the lattice defect is confirmed by the following characteristics of the exciton spectrum: (The complex structure of the valence band in CdS-crystals is a function of a corresponding sub-band, according to J.S.Birman (Phys. Rev. Lett., 2, 157, 1959) and Ye. F. Gross et al. (DAN SSSR, 140, 1285, 1961; FTT, 4, 207, 1962)). The single line λ4888.6 Å and group of lines in the interval 4870-4858 Å belong to the first term (n=1) of the exciton series $(\Gamma_9-\Gamma_7)$. The lines 4864.0; 4861.0 and 4838 Å belong to the first term of the exciton series $(\Gamma_7-\Gamma_7)_1$. The lines 4864.0; 4861.0 and 4888.6 Å are connected with the same impurity center. The fine lines 4820.5 and 4818.3 Å observed in

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Bound excitons and band...

the region of exciton lines are caused by the excited states n=2 or n=3 of the exciton (Γ_9-Γ_7). There is a correlation between exciton lines and corresponding fine lines. The spectrum of free and bound excitons is shown in Fig. 1. The different influence of the CdS-crystal deformation on each type of free and bound excitons is verified by continuing previous investigations (of Ye. F. Gross, B. S. Razbirin (ZhTF, 27, 2173, 1957; 28, 237, 1958) of absorption and reflection spectra of a crystal having one end attached to a glass base. The lines of the series (Γ_9-Γ_7) and the corresponding lines of bound excitons are notably more curved than those of the series (Γ_7-Γ_7) and the corresponding lines of the bound excitons. Lines that appertain to free and the corresponding bound excitons in one series are the same. This characteristic of free and bound excitons produced from the same valence sub-band is also confirmed the shift of the lines caused by temperature. There are 2 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

44195

S/181/62/004/012/051/052
B125/B102

24,36 10

AUTHORS: Gross, Ye. F., and Suslina, L. G.

TITLE: The emission spectrum of hexagonal ZnSe single crystals

PERIODICAL: Fizika tverdogo tela, v. 4, no. 12, 1962, 3677-3680

TEXT: The "edge-emission" (emission on the long-wave side of the fundamental absorption edge) from hexagonal monocrystalline plates and from coarse crystalline sinters and powders of ZnSe, is described for the exciton structure of the ZnSe absorption investigated earlier (Ye. F. Gross et al., FTT, 4, 396, 1962). A similar edge emission (i.e. a series of narrow emission lines) from a fair number of oxide and sulfide crystals (ZnS, ZnO, CdS and others) has been observed by F. A. Kroeger (Physica, 7, 4, 1940) and other workers. The emission spectra excited by light in the range of selfabsorption of ZnSe at 77°K and 4.2°K have been photographed using a ИСП-51 (ISP-51) spectrograph with linear dispersion. The excited ZnSe-monocrystals glow light green at low temperatures. All spectral lines of the ZnSe-monocrystals with a Wurtzite-structure are polarized normal to the optical axis at T = 4.2°K.

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The emission spectrum of...

The first and very intensive emission line of such a spectrum with a maximum λ4326 Å is located among the first very long-wave absorption lines with 4335 and 4311 Å. The intensities of the equidistant line series 4361, 4405, 4454, 4501 Å decrease with increasing wave length. The position of emission lines of different monocrystalline samples differs by several Å as a result of some inner deformations. The equidistant series of various samples mentioned can contain various numbers of lines. Powders and coarse crystalline sinters display the most intensive equidistant luminescence and also the most numerous equidistant lines. At 4.2°K there is a green band at 5150 Å (causing the luminescence observed) and there is a red band at 6000 Å. If the temperature is raised to 77°K the equidistant series disappears, the strong emission line at 4326 Å is shifted to 4320 Å, and the "red" and "green" bands become more smeared out, showing a red shift. The frequency of 240 cm^{-1} observed belongs to the longitudinal oscillations of the ZnSe-lattice. The transverse frequencies of CdS (Wurtzite-structure), ZnSe (sphalerite-structure) and CdSe (Wurtzite-structure) amount to 260, 215-218 and 185 cm^{-1}. The longitudinal frequencies of CdS, ZnSe and CdSe (all having a Wurtzite-structure) amount to 300, 240, and 213 cm^{-1}. The

The emission spectrum of...

present authors established a far reaching analogy between the absorption spectra of ZnO and those of ZnSe. There are 1 figure and 1 table.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: August 31, 1962

Card 3/3

S/053/62/076/003/001/005
B125/B102

AUTHOR: Groß, Ye. F.

TITLE: The exciton and its motion in a crystal lattice

PERIODICAL: Uspekhi fizicheskikh nauk, v. 76, no. 3, 1962, 433-466

TEXT: The present review on excitons and their motion in crystal lattices takes into consideration all the papers published from 1927 to 1962, except theoretical studies. There are 24 figures, 1 table, and 110 references: 67 Soviet-bloc and 43 non-Soviet-bloc.

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37381
S/020/62/143/006/010/024
B163/B102

AUTHORS: Gross, Ye. F., Corresponding Member of the AS USSR, and Chang Kuang-yin

TITLE: Exciton reflexion spectrum of a cuprous oxide crystal in the ultraviolet region

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 143, no. 6, 1962, 1321-1324

TEXT: From the band scheme of Cu_2O proposed by Elliott, Zhilich, and Moskalenko (e.g. Phys. Rev. 124, 340, 1961) it can be concluded that the exciton spectrum is extended beyond the hitherto known line groups in the visible spectrum into the ultraviolet region. This is also suggested by the experimental data on photoelectric phenomena (photoconductivity maximum at 2800 Å) but the absorption in Cu_2O crystals has hitherto not been directly observed in the UV region because of the high values of the absorption coefficient in this region. An improved reflexion method which has been described earlier (Gross et al., Fiz. tverd. tela, v. 4, 261, 1962) was used to measure the reflexion spectrum between 2000 and 4000 Å with a

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S/020/62/143/006/010/024
B163/B102

Exciton reflexion spectrum of...

Q 12 Zeiss quartz spectrograph and a BY-1 (VU-1) hydrogen lamp as radiation source. Cu_2O monocrystals whose surfaces were etched with nitric acid were investigated at 77°K with polarized light in the p-component at an incidence angle of 70°. Three reflexion maxima were found at 3410 Å, (3.64 ev), 2860 Å (4.33 ev), and 2620 Å (4.73 ev). These maxima were broader than the maxima in the visible spectrum. Measurements with an C_2-4 (SF-4) spectrophotometer at room temperature and an incidence angle of 30° yielded maxima at 3590 Å (3.45 ev), 2920 Å (4.26 ev), 2560 Å (4.84 ev), 2330 Å (5.32 ev), and 2200 Å (5.63 ev). The UV bands are attributed to the excitation of electrons from deeper valence bands to exciton levels beside higher conductivity subzones. There are 3 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe Akademii nauk SSSR (Physical-technical Institute imeni A. F. Ioffe of the Academy of Sciences USSR)

SUBMITTED: February 6, 1962

Card 2/2

S/020/62/146/003/009/019
B101/B144

AUTHORS: Gross, Ye. F., Corresponding Member AS USSR, Chang Kuang-yin, Solov'yev, L. Ye.

TITLE: Absorption spectrum in the light-blue and dark-blue spectral ranges and deformation effects in thin specimens of coprous oxide

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 146, no. 3, 1962, 577-580

TEXT: Absorption and reflection spectra of Cu_2O specimens were taken at 4.2 and 77.3°K to check the assumption (Ref. 1: Fiz. tverd. tela, 4, 261, 827 (1962)) that the observed splitting of spectral lines of the Cu_2O single crystal is caused by deformation effects. In the absorption spectrum of a specimen 1 μ thick, the intense light-blue lines $\lambda_1^{(1b)'}$ = 4817 Å, $\lambda_1^{(1b)''}$ = 4777 Å, and the weak lines $\lambda_2^{(1b)'}$ = 4740 Å and $\lambda_2^{(1b)''}$ = 4724 Å were observed, which are interpreted as a splitting of

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S/020/62/146/003/009/019
B101/B144

Absorption spectrum in the ...

the lines $\lambda_1^{(lb)}$ = 4796 Å and $\lambda_2^{(lb)}$ = 4733 Å observed in the reflection spectrum. This was confirmed by the reflection spectrum of a wedge-shaped Cu_2O specimen, where the splitting increased with decreasing wedge thickness, whereas no splitting was observed for a Cu_2O lamina of 10-15 μ thickness. Likewise, the dark-blue lines $\lambda_1^{(db)}$ = 4569 Å and $\lambda_2^{(db)}$ = 4505 Å were split in the wedge-shaped specimen. With a 5 μ thick Cu_2O specimen, these lines were split into two perpendicularly polarized lines. As $\lambda_1^{(lb)}$ and $\lambda_1^{(db)}$ are more intense than $\lambda_2^{(lb)}$ and $\lambda_2^{(db)}$ it is concluded that they are allowed lines of hydrogen-like exciton series: light-blue series $\lambda_n^{(lb)} = 21220 - 368/n^2$ cm^{-1}, n = 1, 2, ...; dark-blue series $\lambda_n^{(db)} = 22302 - 415/n^2$ cm^{-1}, n = 1, 2, ... A band diagram is suggested (Fig. 4) which, complementary to Ref. 1, is confirmed by new experimental data: Between 4.2 and 77.3°C, the differences between the temperature coefficients of the yellow and green series are equal to those between the light-blue and dark-blue series.

Card 2/4 3

Absorption spectrum in the ... S/020/62/146/003/009/019
B101/B144

If the dielectric constants of all series are set equal to each other, then $(R^{(db)} - R^{(lb)})/(R^{(g)} - R^{(y)}) = R^{(db)}R^{(lb)}/R^{(g)}R^{(y)}$ holds for the experimental values of the Rydberg constants $R^{(y)} = 780.7$, $R^{(g)} = 1200$, $R^{(lb)} = 368$, $R^{(db)} = 415$ cm^{-1}. In all four exciton series, the deformation effect acts primarily on the conductivity band. Under the action of stress the conductivity sub-band Γ_6^+ is slightly shifted, and the Γ_{12}^- sub-band is split. There are 4 figures. The most important English-language references are: J. B. Grun, M. Sieskind, S. Nikitine, J. Phys. Chem. Solids, 21, 119 (1961); R. J. Elliott, Phys. Rev., 108, 1384 (1957); 124, 340 (1961).

SUBMITTED: June 18, 1962

Card 3/4 3

S/020/62/146/005/005/011
B125/B186

AUTHORS: Gross, Ye. F., Corresponding Member AS USSR, Nedzvetskiy, D. S.

TITLE: Resonance and non-resonance radiation of centers in a GaP crystal and interaction with the lattice phonons

PERIODICAL: Akademiya nauk SSSR. Doklady, v. 146, no. 5, 1962, 1047-1050

TEXT: The luminescence of exceptionally pure GaP crystals was studied at $T = 4.2^{\circ}K$. About 100 lines were discovered in the luminescence spectrum, formed probably by superimposition of several spectra. A group of intense lines was separated out; this recurs regularly (up to seven times with sufficient exposure), decreasing in intensity each time. Comparison of the absorption spectrum with the luminescence spectrum shows that the absorption line ν_0 corresponds to direct electron transition. The broad luminescence and absorption lines are approximately symmetric with respect to the ν_0 line. The slight deviation from Levshin's law of mirror symmetry is probably due to size differences of the phonons in the excited and the non-excited electron states. A very intense, narrow, sharp line of

Resonance and non-resonance...

non-phonon transition was newly discovered in the center between the mirror-symmetric bands of the absorption and luminescence spectra. This experimental discovery confirms the theoretical conclusions drawn by Ye. D. Trifonov (DAN 147, no. 4 (1962)) on the luminescence of local centers in the crystal lattice. These centers may be bound excitons. There are 4 figures and 3 tables.

SUBMITTED: July 16, 1962

Fig. 3. Diagram of the luminescence and absorption spectra in a GaP crystal. А - complete luminescence spectrum; Б - absorption spectrum; В - spectrum of broad luminescence lines associated with acoustic and optical phonons; Г - spectrum of line luminescence associated with optical limit phonons; Д,Е - spectra of the individual luminescence lines and their interaction with optical limit phonons; Ж - many-line spectrum of weak, narrow lines, and adjacent region of the continuous spectrum.

S/020/62/146/005/005/011
B125/B186

Resonance and non-resonance...

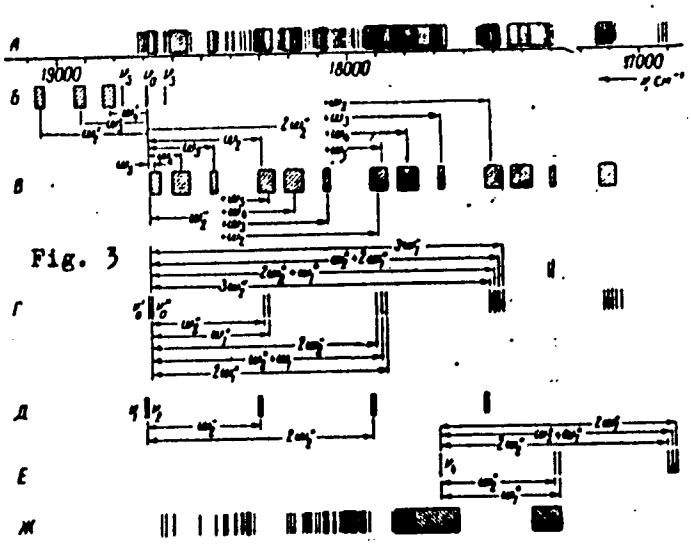

Fig. 3

Card 3/3

GROSS, Ye.F.; RAZBIRIN, B.S.; PERMOGOROV, S.A.

Free and bound excitons in cadmium sulfide crystals and the analogue of the Mössbauer effect in optics. Dokl. AN SSSR 147 no.2:338-341 N '62. (MIRA 15:11)

1. Chlen-korrespondent AN SSSR (for Gross).
(Cadmium sulfide crystals)
(Excitons) (Mössbauer effect)

S/181/63/005/001/047/064
B108/B180

AUTHORS: Agekyan, V. T., Gross, Ye. F., Zakharchenya, B. P., and Kaplyanskiy, A. A.

TITLE: Piezomagneto-optical investigation of the quadrupole exciton transition in Cu_2O crystals

PERIODICAL: Fizika tverdogo tela, v. 5, no. 1, 1963,315-319

TEXT: The effect of a magnetic field $\vec{H}$ (30 koe) and a compression P perpendicular to H upon the quadrupole exciton line n = 1 (transition $\Gamma_1^+ \to \Gamma_{25}^+$) in the Cu_2O spectrum, was studied on a Cu_2O single crystal compressed along the [001] axis. The spectrum was taken on a [illegible]-3 (DFS-3) spectrograph with linear dispersion 2 A/mm. Observations were made in polarized light ($\vec{E} \parallel P$ and $\vec{E} \perp P$) perpendicularly to both H and P. Without pressure, the n=1 line (λ = 6125 A) is split into a triplet with its central line (polarized $\vec{E} \parallel \vec{H}$) in the position of the old line. The other two (polarized $\vec{E} \perp H$) have equal intensities and are symmetric about the central line. With rising pressure the central line shifts to longer

waves, and the short-wave line to shorter waves with intensity increased at the expense of the long-wave line. Above 2 kg/mm^2 the long-wave line vanishes, leaving the other two polarized with equal intensities. These results are in full agreement with results obtained by solving the secular equation for the splitting of the Γ_{25}^{+} level in the presence of an elastic deformation and a magnetic field (A. G. Zhilich. FTT, 3, 2041, 1961). There are 3 figures and 1 table.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad); Leningradskiy gosudarstvennyy universitet (Leningrad State University)

SUBMITTED: August 14, 1962

S/181/63/005/001/049/064
B108/B180

AUTHORS: Gross, Yo. F., Zhilich, A. G., Zakharchenya, B. P., Makarov, V. P., and Sibilov, A. I.

TITLE: Zeeman effect of the yellow exciton series in strong magnetic fields

PERIODICAL: Fizika tverdogo tela, v. 5, no. 1, 1963, 327-338

TEXT: The Zeeman effect of the members of the yellow exciton series of directed Cu_2O crystals was examined in magnetic fields of up to 140 koe in the direction perpendicular to the magnetic field. The crystals were cooled in liquid helium. With increasing field strength the line splitting grows more complex with rising main quantum number n (Paschen-Bak effect). The experiments with single crystals showed clear dependence between the splitting and the orientation of the crystal in the magnetic field. The Zeeman splitting of the principal members of the yellow series with $n \geq 2$ is distorted by the action of forbidden lines. Conclusions: In Cu_2O there is a Γ_{25}^+ zone at the top of the valency band an a Γ_1^+ zone at the bottom

of the conduction band. If the former is assumed to be due chiefly to the 2p-state of the oxygen, one can neglect the spin-orbit interaction. If, however, the Γ_{25}^{+} valency band is mainly due to the 3d-state of Cu, the spin-orbit interaction will split it into a doubly degenerate Γ_{7}^{+} and a quadruply degenerate Γ_{8}^{+} band (at $\vec{k} = 0$). These two band models are used to develop the theory of the Zeeman effect of directly forbidden excitons. Theory and experiment do not, however, fully agree. The Γ_{25}^{-}, Γ_{2}^{-}, Γ_{12}^{-} symmetry levels may affect the magnetic sublevels that are due to the splitting of the Γ_{15}^{-} level. There are 3 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: August 14, 1962

S/181/63/005/002/018/051
B104/B102

AUTHORS: Gross, Ye. F., and Shekhmamet'yev, R. I.

TITLE: Study of the excitation spectrum of the edge luminescence of copper halides

PERIODICAL: Fizika tverdogo tela, v. 5, no. 2, 1963, 502-505

TEXT: The object here is to bring out a relationship between the edge luminescence and the exciton absorption lines in the absorption spectrum of crystals. The luminescence excitation spectra of polycrystalline CuI, CuBr and CuCl layers were studied at 77°K in the region of exciton absorption. The specimens were produced according to Gross et al. (Opt. i spektr., VIII, 232, 1960). The luminescence was excited by the monochromatic light of an incandescent lamp and recorded spectrally. Resolution was such that lines of 15 to 20 Å width could be separated. Results: the edge luminescence of the copper halides is connected with the exciton absorption lines. These lines correspond to the minima of the luminescence excitation curves. The fact that the exciton absorption lines do not correspond to the maxima of the luminescence excitation curves

Card 1/2

Study of the excitation spectrum ...

is ascribed to the high defect concentration. There are 3 figures.

ASSOCIATION: Leningradskiy gosudarstvennyy universitet
(Leningrad State University)

SUBMITTED: August 27, 1962

Card 2/2

S/181/63/005/003/016/046
B102/B180

AUTHORS: Gross, Ye. F., Suslina, L. G., and Livshits, A. I.

TITLE: Reflection and luminescence of zinc telluride single crystals

PERIODICAL: Fizika tverdogo tela, v. 5, no. 3, 1963, 801-806

TEXT: This is the third paper in a series of studies of the optical properties of ZnS - ZnSe - ZnTe crystals (Opt. i spektr., 8, 516,1960;FTT, 4, 396, 1962); it describes investigations made in the visible and ultraviolet ranges at 293, 77 and 4.2°K, including also luminescence at 4.2°K. For the reflection spectra a -51 (ISP-51) spectrograph was used for the visible and a Q-12 for the UV ranges. At 77°K a narrow reflection peak was observed at 5236.3±0.3 Å (2.3675 ev) which, at 4.2°K, shifted to 5209.3±0.1Å (2.3798 ev). At room temperature only two broad diffuse maxima were found, one at 3600±50 Å (3.44 ev), the other at 3100±50 Å (4.00 ev). Which at 77°K, these maxima shifted to shorter waves (3330±5 and 2865±3 Å) and narrowed considerably from 2700 to 230 cm^{-1}, and from 2000 to 140 cm^{-1}. The 5236.3Å peak is attributed to

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direct transitions exciton states connected with extrema, at k=0 (Γ-point), of the lower conduction and the upper valence bands; 3330 and 2865 Å to direct transitions to exciton states connected with extrema of the two valence bands and the conduction band, lying at k (111) at the edge of the Brillouin zone (L-point). The luminescence spectrum observed differed somewhat from that of D. G. Thomas et al. (Phys. Rev. Lett., 8, 391, 1962; Phys. Rev., Ser. II, 122, 1382, 1961). Luminescence was excited by irradiation in the self-absorption band and was taken on the ISP-51 spectrograph. The three types of ZnTe crystal (I, II, III) investigated have different types of spectra due to different types of luminescence centers. I has a spectrum similar to CdS; it has a narrow line at 5222 Å, a group of lines in the range 5240-5500Å and several bands at λ 5536Å. II has a simpler spectrum consisting of 9 - 10 equidistant triplets. Type III was studied in greatest detail; it consists of narrow lines of different intensity; a faint line at 5222Å, a group of equidistant intense lines at 5288Å, and other groups at 5316, 5452, 5528, 5619, and 5834 Å. Common to all types of crystals are the 5222 Å (exciton) line and the presence of line groups whose intensity decreases

Reflection and luminescence of ...

toward the red side of the spectrum. The lines of these groups are equidistant (~0.026 ev) and are attributed to longitudinal lattice vibrations. There are 10 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute imeni A. F. Ioffe AS USSR, Leningrad)

SUBMITTED: October 4, 1962

Card 3/3

GROSS, Ye.F.; NEDZVETSKIY, D.S.

Fine structure of the damping times for edge radiation bands in GaP crystals. Dokl. AN SSSR 152 no.2:309-312 S '63.
(MIRA 16:11)

1. Chlen-korrespondent AN SSSR (for Gross).

GROSS, Ye.F.; NEDZVETSKIY, D.S.

Generation of long-wave edge-luminescence bands in GaP crystals. Dokl. AN SSSR 152 no.6:1335-1338 O '63. (MIRA 16:11)

1. Chlen-korrespondent AN SSSR (for Gross).

GROSS, Ye.F.; KOCHNEVA, N.S.; NEDZVETSKIY, D.S.

Free and bound excitons in GaP crystals. Dokl. AN SSSR 153 no.3:574-577 N '63. (MIRA 17:1)

1. Chlen-korrespondent AN SSSR (for Gross).

AKOPYAN, Y. Kh.; GROSS, Ye. F.; DREYNGOLD, F. I.; NOVIKOV, B. V.; TITOV, R. A.; SHERKHMAMETYEV, R. I.

"The investigation bythe photoconductivity and luminescence method of the exciton states near the edge and in the depth of the fundamental absorption in crystals."

paper submitted for Intl Conf on Physics of Semiconductors, Paris, 19-24 Jul 64.

Leningrad State Univ.

L 10809-65 EWT(l)/EW[illegible]/EEC(b)-2/EWP(b) IJP(c)/BSD/RAEM(a)/APGC(b)/
ESD(t)/AFWL/ASD(a)-5/AS(mp)-2/ESD(ge)
ACCESSION NR: AP4046733 S/0054/64/000/003/0007/0010

AUTHOR: Gross, Ye. F., Nedzvetskiy, D. S.

TITLE: Linear and continuous red luminescence in crystals of GaP

SOURCE: Leningrad. Universitet. Vestnik. Seriya fiziki i khimii, no. 3, 1964, 7-10

TOPIC TAGS: emission, emission spectrum, luminescence, semiconductor, indium phosphide, impurity center, transition

ABSTRACT: An attempt is made to interpret the emission spectrum of GaP, which at 4.2 K consists of a great number of narrow lines and a continuous wide band, by making use of the available experimental data of the authors and other researchers. It was determined that the intensity of the six narrow equidistant emission lines increases with increasing temperature and that between the temperature of liquid helium and liquid nitrogen their intensity is several times greater than the intensity at 4.2K. The emission of all the lines in the red part of the spectrum can be excited by blue and longer wavelength red

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L 10809-65
ACCESSION NR: AP4046733 O

radiation. On the basis of an analysis of all the experimental data, the existence of this group of six lines was attributed to phonon-assisted electronic transitions at an impurity center. If the shortest wavelength line at 6497.2Å is attributed to an electronic transition, the rest of the lines can be interpreted as the same transition accompanied by one, two, three, four, and five phonons. Orig. art. has: 2 figures and 1 table.

ASSOCIATION: none

SUBMITTED: 10Oct63 ATD PRESS: 3117 ENCL: 00

SUB CODE: SS, EM NO REF SOV: 006 OTHER: 006

Card 2/2

ACCESSION NR: AP4041729 S/0181/64/006/007/2180/2183

AUTHORS: Gross, Ye. F.; Nedzvetskiy, D. S.

TITLE: Change in luminescence spectrum of GaP crystals as a function of the intensity of the exciting light

SOURCE: Fizika tverdogo tela, v. 6, no. 7, 1964, 2180-2183

TOPIC TAGS: gallium compound, luminescence spectrum, crystal formation, spectrum intensity, light excitation, electron capture

ABSTRACT: This is a continuation of earlier investigations of the strong dependence of the luminescence spectra of "pure" GaP crystals on the method of their preparation (DAN SSSR v. 146, 1047, 1962; 152, 309, 1963; 154, 64, 1964). In the present study the authors observed for the first time a radical change in the relative intensity of these spectra at very low intensity of the exciting light. Using blue light from an SDVSh-500 mercury light at 4.2K, spectra

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ACCESSION NR: AP4041729

A, B, and C of Enc. 01 were observed. When the light intensity was reduced to one-tenth, spectrum A, which originally was brightest, was strongly attenuated, and spectrum B became brightest. Further decrease of the intensity to 1/100 of the initial value left only the end bands of spectrum B. Spectrum A could not be photographed even when spectrum B was over exposed. This points to the presence of a threshold excitation intensity, below which only the edge bands are excited in GaP, and the remaining luminescence spectra do not appear. This threshold value varied from crystal to crystal. The phenomenon is explained by assuming that the electron capture cross section for the centers producing spectrum B is much larger than for the other spectra. Orig. art. has: 2 figures.

ASSOCIATION: Leningradskiy gosudarstvenny*y universitet (Leningrad State University)

SUBMITTED: 29Jan64

ENCL: 01

Card 2/4

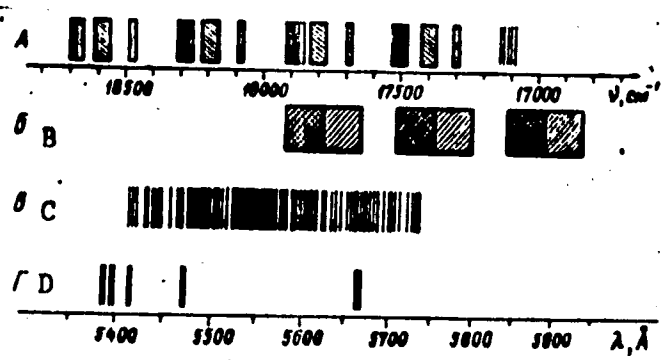
ACCESSION NR: AP4041729

SUB CODE: SS NR REF SOV: 006 OTHER: 006

Card 1 3/4

ACCESSION NR: AP4041729

ENCLOSURE: 01



Schematic diagram of four main luminescence spectra observed in GaP crystals at 4.2K

A - luminescence of bound excitons and their phonon repetitions, B - band-type edge luminescence, C - Multiple line spectrum of weak narrow line, D - hydrogen-like series of luminescence lines (phonon repetitions of these lines are not shown in the figure)

Card 4/4

L 18240-65 EWT(1)/EWT(m)/EPC(b)-2/EWP(t)/EWP(b) IJP(c)/BSD/SSD(c)/ASD(a)-5/
AS(mp)-2/AFWL/RAEM(a)/RAEM(c)/APGC(b)/RAEM(j)/ESD(gs)/ESD(t) RDW/JD
ACCESSION NR: AP5000670 S/0181/64/006/012/3684/3690

AUTHORS: Gross, Ye. F.; Suslina, L. G.

TITLE: Mirror symmetry of absorption and luminescence spectra of ZnTe crystals

SOURCE: Fizika tverdogo tela, v. 6, no. 12, 1964, 3684-3690

TOPIC TAGS: absorption spectrum, luminescence spectrum, single crystal, zinc alloy, spectrum analysis

ABSTRACT: The authors investigated the narrow-line absorption and luminescence spectrum of the cubic modification of single-crystal ZnTe (sphalerite). The tests were made at 4.2K. The luminescence and absorption spectra were studied photographically using an ISP-51 spectrograph with a linear dispersion of 18 Å/mm in the 5400 Å region. To investigate the intensity and the temperature dependence of the emission lines, an ISP-51 spectrograph was used in conjunc-

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tion with an EFP-1 attachment. The results have shown that the luminescence and absorption lines can be grouped into several equidistant series, the distance between lines in each series being approximately equal to the energy of the longitudinal vibration of the optical branch of the ZnTe lattice (approx. 0.026 eV). Mirror symmetry of the luminescence and of the absorption about the phononless line was observed for two electron-vibrational series. An investigation of the ratio of the integral intensities in the equidistant series of luminescence lines has shown that this ratio agrees with that derived theoretically by Pekar (UFN v. 50, 197, 1953) and M. A. Krivoglaz (Opt. i spektr. v. 1, 54, 1956). "In conclusion the authors thank B. P. Zakharchenya and L. M. Kanskaya for photographing the ZnTe absorption spectra in a magnetic field, and also Ye. D. Trifonov and K. K. Rebane for a discussion of some problems involved in this work." Orig. art. has: 3 figures and 1 formula.

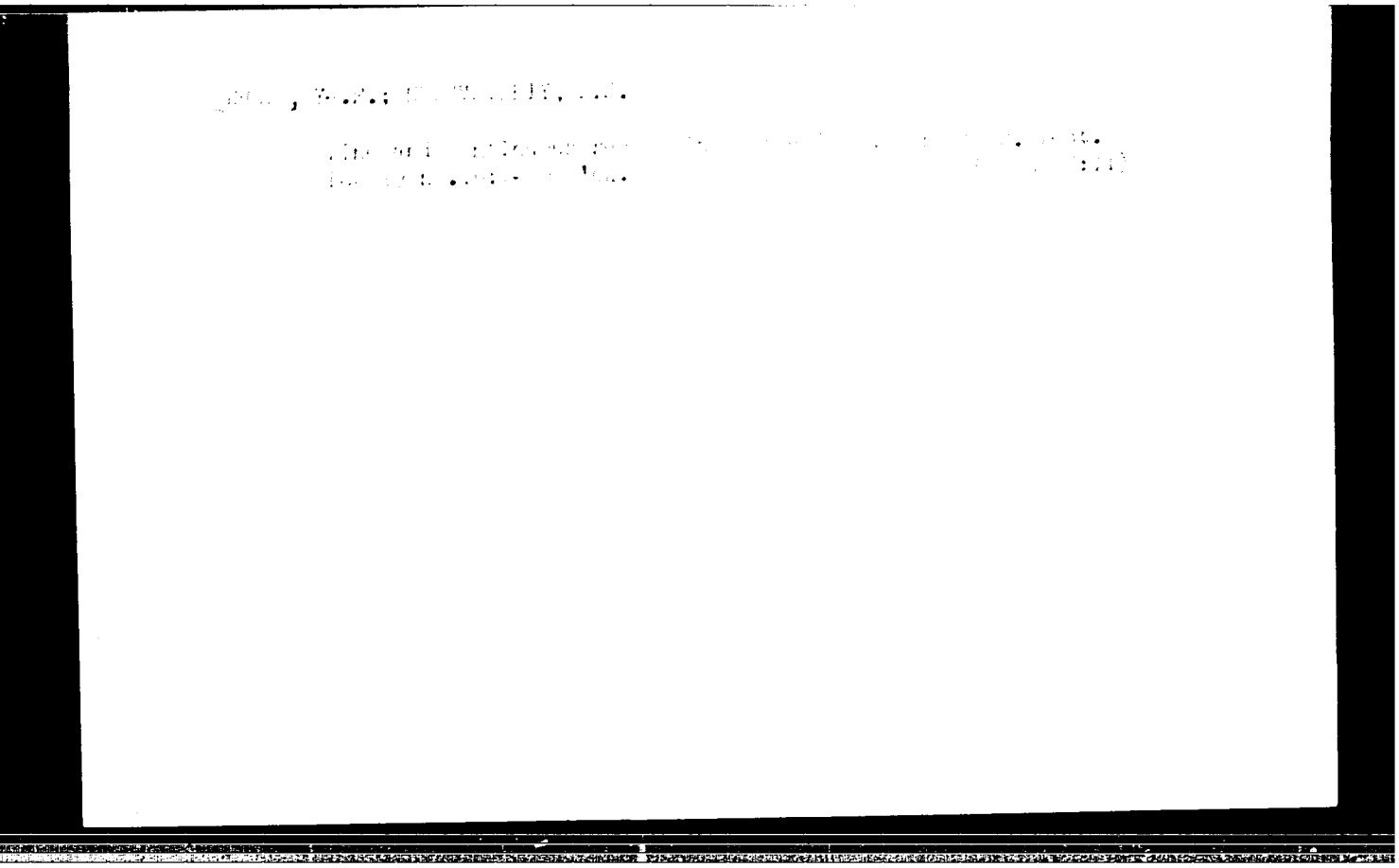
L 18240-65
ACCESSION NR: AP5000670

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR Leningrad (Physicotechnical Institute AN SSSR)

SUBMITTED: 28Apr64 ENCL: 00

SUB CODE: OP, SS NR REF SOV: 009 OTHER: 005

Card 3/3



ACCESSION NR: AP4010750 S/0020/64/154/001/0064/0067

AUTHOR: Gross, Ye. F. (Corresponding member); Nedzvetskiy, D. S.

TITLE: Converging line spectrum of luminescence in GaP-crystals

SOURCE: AN SSSR. Doklady*, v. 154, no. 1, 1964, 64-67

TOPIC TAGS: GaP-crystals, crystals luminescence, hydrogen-like line spectra, crystal lattice defects, impurities in crystals, acceptor energy levels

ABSTRACT: It has been previously found by several investigations that the luminescence spectra of GaP greatly depend on the excitation conditions which indicates that impurities and lattice defects affect the luninescence. It is shown in the present paper that in some of the investigated GaP-crystals the luminescence spectrum contains many lines, and can be considered as a superposition of several spectra. In addition to the spectra previously reported, this group of crystals shows a line sequence apparently of a common origin. The position of the lines can be described by a Balmor-like formula. The intensity of the

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ACCESSION NR: AP4010750

lines of this sequence is temperature dependent. Similar spectra were found in silicon by S. Zwerdling et al. (Phys. Rev. Letters 4, 173 (1960)) and attributed to acceptor levels. Orig. art. has: 4 figures and 2 tables.

ASSOCIATION: None

SUBMITTED: 27Jul63 DATE ACQ: 10Feb64 ENCL: 00

SUB CODE: PH NO REF SOV:003 OTHER: 008

Card 2/2

ACCESSION NR: AP4019969 S/0020/64/154/006/1306/1309

AUTHORS: Gross, Ye.F. (Corr. member AN SSSR);); Permogorov, S.A.; Razbirin, B.S.

TITLE: An optical analog of the Mossbauer effect

SOURCE: AN SSSR. Doklady*, v. 154, no. 6, 1964, 1306-1309

TOPIC TAGS: optics, Mossbauer effect, phononless transition, crystal, crystal spectrum, cadmium sulfide, cadmium selenide, zinc sulfide

ABSTRACT: Very sharp lines have been found in crystals such as CdS, CdSe, ZnS, and some others in both emission and absorption at 4K near the fundamental absorption edge (see Fig. 1 of the Enclosure). Their width is about 10^{-4} ev. The purely electronic (phononless) transitions which correspond to these lines seem to be similar to the narrow lines in the gamma spectra (Mossbauer effect). The present authors have investigated the temperature dependence of these lines in the range between 4 and 26K (see Fig. 2 of the Enclosure). This dependence is similar to that of the Mossbauer effect except that the tempera-

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ACCESSION NR: AP4019969

ture range is much lower than that for the latter. "The authors are grateful to Ye. D. Trofimov for many discussions." Orig. art. has: 3 figures.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A.F. Joffe Akademii nauk SSSR. (Physicotechnical Institute, Academy of Sciences,SSSR)

SUBMITTED: 07Sep63 ATD PRESS: 3055 ENCL: 02

SUB CODE: SS, OP NO REF SOV: 008 OTHER: 008

Card 2/4

ACCESSION NR: AP4019969

ENCLOSURE: 01

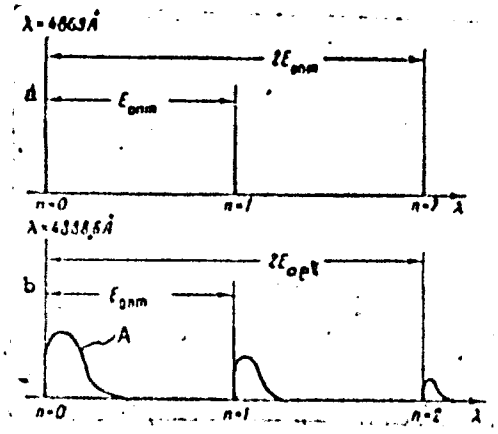

Fig. 1. Schematic representation of electron vibrational spectrum for the irradiation of CdS crystal at T = 4.2K: a - in the case of the interaction with optical phonons only; b - in the case of interactions with optical and acoustic (A) phonons

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ACCESSION NR: AP4019969

ENCLOSURE: 02

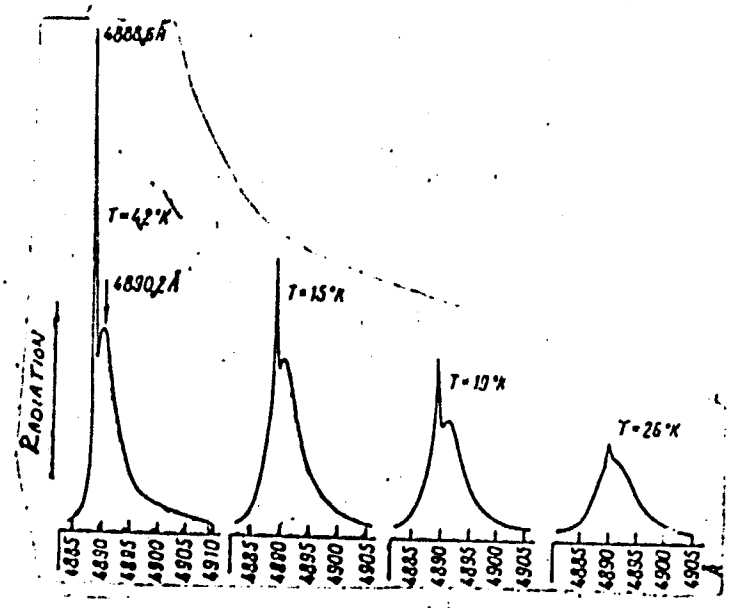

Fig. 2. Change of the line λ = 4888.6Å and the band, depending upon interactions with acoustic phonons and the temperature

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L 24763-65 EWT(1)/EWT(m)/T/EWP(t)/EEC(b)-2/EWP(b) IJP(c) JD

ACCESSION NR: AP5003456 S/0181/65/007/001/0291/0293

AUTHORS: Gross, Ye. F.; Suslina, L. G.; Mokerov, V. G.

TITLE: Narrow-line luminescence of hexagonal ZnS crystals

SOURCE: Fizika tverdogo tela, v. 7, no. 1, 1965, 291-293

TOPIC TAGS: zinc sulfide, luminescence, luminescence spectrum, single crystal, polycrystal, line spectrum

ABSTRACT: Continuing their investigations of absorption and luminescence of ZnS crystals (Opt. i spektr. v. 6, 115, 1959 and v. 8, 516, 1959; Izv. AN SSSR, ser. fiz. v. 25, 532, 1961), the authors undertook a more detailed study of the luminescence of ZnS and observed narrow-band luminescence on the edge of its main absorption. The experiments were made with polycrystals and single crystals of hexagonal modification, and the spectrum was recorded photographically. The results are shown in Fig. 1 of the enclosure and demon-

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strate that hexagonal single crystals and polycrystals of ZnS have entirely different emission spectra. The narrow-line component of the polycrystal spectrum consists of equidistant lines (width 360 ± ± 10 cm^{-1}) and disappears when the temperature is raised from 4.2 to 77K. It is attributed to the radiation of bound excitons and their interaction with the lattice phonons. The edge luminescence has a more complicated structure. The properties of the lines are tabulated. The single-crystal spectrum consists of a large number of luminescence lines (width 5 Å), spaced approximately (170 ± 5) cm^{-1} apart, and is attributed to the electronic transition in the impurity center interacting with the lattice vibration. The reason for the difference between the single-crystal and polycrystal spectra lies to the different content of imperfections in crystals obtained under different growth conditions. Orig. art. has: 1 figure and 1 table.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR

L 24763-65 EWT(1)

ACCESSION NR: AP5003456

(Physicotechnical Institute AN SSSR)

SUBMITTED: 31Jul64 ENCL: 01 SUB CODE: OP, SS

NR REF SOV: 006 OTHER: 003

Card 3/4

L 24763-65
ACCESSION NR: AP5003456

ENCLOSURE: 01

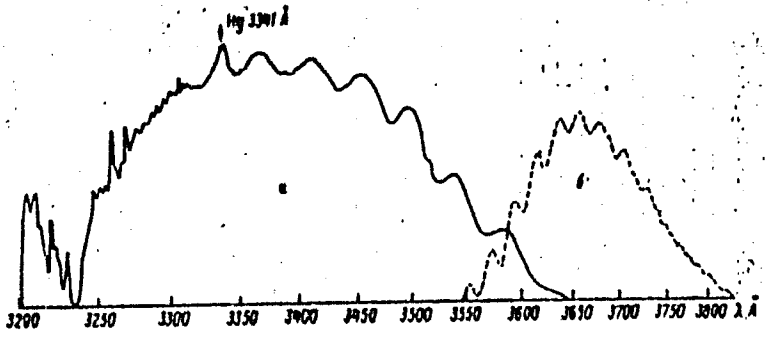

Fig. 1. Microphotograms of the emission spectra of ZnS at T = 4.2K. a - Polycrystals, b - single crystals.

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L 36312-65 EWT(l)/EWT(m)/T/EWP(t)/EEC(b)-2/EWP(b)/EWA(c) IJP(c) JD
ACCESSION NR: AP5005301 S/0181/65/007/002/0558/0564

AUTHOR: Gross, Ye. F.; Razbirin, B. S.; Permogorov, S. A.

TITLE: Afterglow and dependence of the edge radiation spectrum of single-crystal cadmium sulfide on the excitation intensity

SOURCE: Fizika tverdogo tela, v. 7, no. 2, 1965, 558-564

TOPIC TAGS: cadmium sulfide, single crystal, edge radiation, spectrum analysis, afterglow, luminescence center

ABSTRACT: The spectrum was investigated at temperatures of 4.2—77K. The luminescence was excited with light at a wavelength in the region of the intrinsic absorption of the crystal. The light source was a high-pressure mercury arc VRSh-250. A monochromator with photoelectric attachment was used to record the spectra. The results show that the spectrum of the edge radiation depends on the intensity of the exciting light. This dependence is due to the fact that different portions of the spectrum have different luminescence times. The spectrum of the afterglow of the edge radiation of CdS was investigated at T = 4.2K, as well as the temperature dependence of the afterglow spectrum in the interval 4.2—77K. Although early in-

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L 36312-65
ACCESSION NR: AP5005301

vestigations have shown that at low intensities there are three groups of CdS crystals, each with a different type of edge luminescence spectrum, the differences become less pronounced at increased intensity. This indicates that the different sections of the spectrum have a different intensity dependence. It is concluded on the basis of the results that the edge radiation is a consequence of a transition of an electron from a shallow level in the conduction band to a deeper level in the valence band. This is confirmed by the strong temperature dependence of the edge luminescence at low temperature (4—30K). The center responsible for the edge luminescence can be described by the donor-acceptor pair model proposed by F. E. Williams (J. of Phys. Chem. of Solids, v. 12, 265, 1960). The differences between the de-excitation times of the portions of the edge radiation maxima can be attributed to differences in the distances between the donors and the acceptors. Orig. art. has: 4 figures. [02]

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute AN SSSR)

SUBMITTED: 08Aug64 ENCL: 00 SUB CODE: SS, OP

NO REF SOV: 007 OTHER: 009 ATD PRESS: 3219

Card 2/2

L 49031-65 EWT(1)
ACCESSION NR: AP5006881 S/0181/65/007/003/0781/0787

11
10
B

AUTHOR: Agekyan, V. T.; Gross, Ye. F.; Keplyanskiy, A. A. 21

TITLE: Indirect excitons and phonon spectrum of Cu_2O

SOURCE: Fizika tverdogo tela, v. 7, no. 3, 1965, 781-787

TOPIC TAGS: cuprous oxide, phonon spectrum, indirect exciton, uniaxial compression, single crystal, absorption step, compression splitting

ABSTRACT: This is a continuation of earlier studies (FTT v. 2, 2968, 1960 and others) devoted to the influence of inelastic uniaxial compression deformation of Cu_2O single crystals on various elements of the exciton spectrum. The present study was devoted to the influence of uniaxial compression of single crystals on the step of continuous absorption with long-wave edge of 5860 Å in the spectrum of Cu_2O. The samples were elongated with triangular plates 3 x 2 x 0.4 mm in size and the compression was ~30 kg/mm^2 along one of the principal crystallographic directions ⟨100⟩, ⟨111⟩, or ⟨110⟩. The spectrum was photographed with a KSA-1 spectrograph with a glass optical system. An anisotropic reversible splitting of the step

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L 49031-65
ACCESSION NR: AP5006881

was observed upon deformation. The properties of deformation splitting have made it possible to establish that the absorption in the step is due to indirect transitions to the principal 1s-exciton band of Cu_2O producing phonons with $\hbar\omega = 660$ cm^{-1} and with symmetry Γ_{15}^-. Orig. art. has: 1 figure, 1 formula, and 2 tables.

ASSOCIATION: Fiziko-tekhnicheskiy institut im. A. F. Ioffe AN SSSR, Leningrad (Physicotechnical Institute AN SSSR)

SUBMITTED: 15Aug64 ENCL: 00 SUB CODE: OP, SS

NR REF SOV: 010 OTHER: 006

Card 2/2

L 6943-66 EWT(m)/EWP(t)/EWP(b) IJP(c) JD/JG

ACC NR: AP5017325 SOURCE CODE: UR/0181/65/007/007/2217/2219

AUTHOR: Gross, Ye. F.; Safarov, V. I.; Sedov, V. Ye.

ORG: Physicotechnical Institute, im. A. F. Ioffe, AN SSSR, Leningrad (Fiziko-tekhnicheskiy institut AN SSSR)

TITLE: Luminescence of donor-acceptor pairs in GaAs crystals alloyed with Cd

SOURCE: Fizika tverdogo tela, v. 7, no. 7, 1965, 2217-2219

TOPIC TAGS: luminescence spectrum, alloying, semiconducting material, semiconductor theory, ionization phenomenon

ABSTRACT: The photoluminescence spectrum of GaAs crystals, alloyed with Cd by diffusion from the gas phase, was studied as a function of: Cd concentration, temperature (4.2°-28°K), and the intensity of the stimulated light. The alloy concentration was changed by etching the surface where the diffused Cd has passed through. Data obtained at 4.2°K for the luminescence spectrum of crystals having a maximum Cd concentration of about 5×10^{18} cm^{-3} in the unetched condition, showed that in addition to the usual maximum occurring at 8340 Å--designated as region A, a new region 'B' was found at 8495 Å. Upon lowering the Cd concentration by progressively etching off the surface (2, 25, and 50 mk), the maximum in region B was displaced to higher energies or lower wavelengths; finally, it united with region A. For the lowest Cd con-

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L 6943-66

ACC NR: AP5017325

centration, 50 mk etched off, the spectrum did not show the above effect; instead, a visible region of marginal radiation and excitons appeared (designated as region 'c'). For higher Cd concentrations, a decrease in stimulated emission from I_{max}, by a factor of 100, induced the largest displacement of the B region maximum (from 8450 to 856 to 8560 Å), while hardly displacing the A region maximum. By increasing the temperature from 4.2°K, all of the crystals with Cd impurities exhibited a stretching in the region of free exciton emission, while regions A and B weakened in intensity. At higher temperatures, splitting and separation of the A and B maxima occurred in the heavily etched crystals. At 78°K, only regions A and c were visible. An explanation of the observations is given in terms of the donor-acceptor pair model. Accordingly, for electron pair transitions from donor to acceptor levels, radiation of energy $E_g = (E_d + E_a) + e^2 (\varepsilon r)^{-1}$ is emitted. Here, E --width of forbidden zone of the crystal, E_d and E_a--ionization energies of the donors and acceptors, r--distance between the donor and acceptor in a pair, and ε--dielectric constant of the crystal. The data is analyzed using the above-mentioned parameters for the donor-acceptor pair model. For the long wavelength edge of the B region (about 1.44 ev), with r approaching infinity for distant states, E_d is calculated to be 0.05 ev, using literature values for E_g and E_a. It is proposed that donor-acceptor pair interactions in GaAs and *in semiconducting lasers are responsible* for electroluminescence emission, and the associative maxima. Orig. art. has: 2 figures.

SUB CODE: SS/ SUBM DATE: 10Feb65/ ORIG REF: 002/ OTH REF: 007

Card 2/2

L 47053-66 EWT(1)/T IJP(c)

ACC NR: AP6015467 SOURCE CODE: UR/0181/66/008/005/1483/1492

AUTHOR: Gross, Ye. F.; Permogorov, S. A.; Razbirin, B. S.

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TITLE: The motion of free excitons and their interaction with phonons

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ABSTRACT: An investigation is made of the possibility of the manifestation of the kinetic energy of freely moving excitons in an exciton luminescence spectrum. Differences are noted among the processes of a phononless, a one-phonon, and a two-phonon optic annihilation of excitons, related to the different formulation of the law of conservation of momentum for these processes. The results are used to analyze the exciton luminescence spectrum of CdS single crystals in the temperature range of 4—77K. It is shown that excitons in this case may be considered as free quasiparticles following the Maxwell distribution in the kinetic energies and interacting with phonons with the fulfillment of the law of the conservation of momentum. In

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conclusion, the authors consider it their pleasant duty to express their gratitude to K. K. Rebane, V. V. Khizhnyakov, and A. A. Klopikhin for a fruitful discussion of the results, and to V. A. Abramov for assistance in making the measurements. Orig. art. has: 17 formulas and 4 figures.

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